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Joint project „The sugar beet as an energy crop…“

Balance and leaching of nitrogen in energy crop rotations with and without sugar beet

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Introduction

Nitrogen (N) fertilization is essential for plant growth to produce high yielding crops. However, N can have harmful impacts on the environment like eutrophication of water bodies and increasing greenhouse gas emissions. Regulatory constraints, like a max. N surplus of 60 kg N ha^{-1} in the 3-year-average (DÜV, 2012), were set up to retain N in the plant-soil system. Moreover, the improvement of the N fertilization strategy for single crops and crop rotations is an important criterion for the development of sustainable production systems. This study aims to asses N balance and N leaching of different energy crop rotations with and without sugar beet as one factor of sustainable biomass production.

Material & Methods

- energy crop rotations and N fertilization at the three sites (Tab. 1 and 2)

Tab. 2: Mean N fertilization at research sites (2011-2013).

	Aiterhofen	Harste	Etzdorf
		[kg ha^{-1}]	
sugar beet	105	90	100
silage maize	205	120	140
winter wheat	220	205	160

- N fertilization of mustard: 40 kg ha^{-1} (Aiterhofen) and 50 kg ha^{-1} (Harste)
- additional N fertilization of winter wheat after pre-crop winter wheat: 40 kg ha^{-1} in autumn (Aiterhofen)
- N balance calculated as N input (mineral fertilizer) minus removal by crop material harvested
- crop specific N leaching modelled (NDICEA; VAN DER BURGT *et al.*, 2006) from sowing till sowing of the subsequent crop

Tab. 1: Crop rotations at the three sites (2011-2013).

	Aiterhofen	Harste	Etzdorf
(mustard) SB-WW-WW	x	x	
(mustard) SM-WW-WW	x	x	
(mustard) SM-SB-WW	x	x	
SM monoculture		x	x
SB monoculture		x	x
WW monoculture		x	x

SB = sugar beet, SM = silage maize, WW = winter wheat
x: crop rotation was grown on the respective site

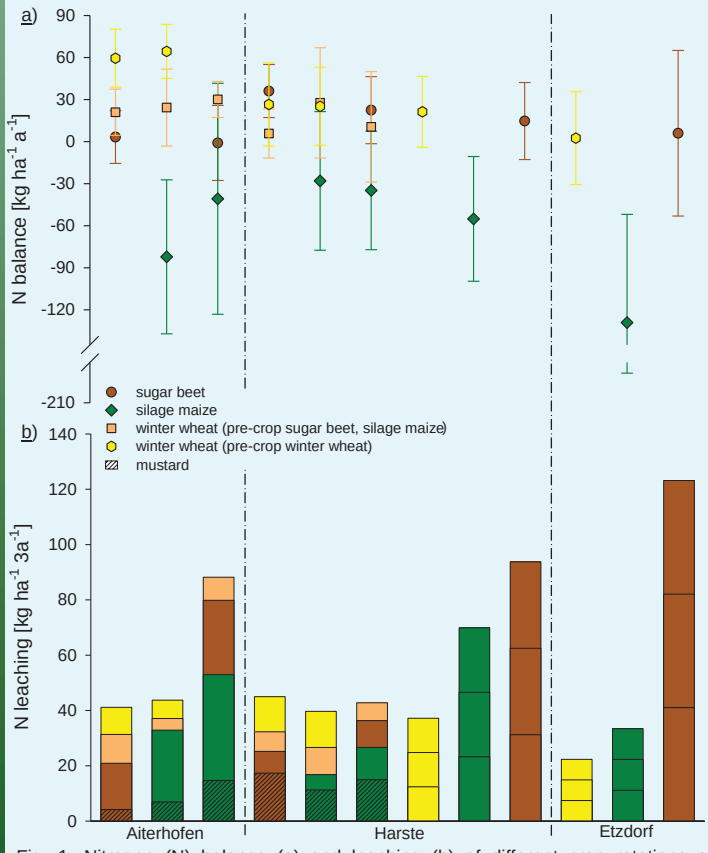

Fig. 1: Nitrogen (N) balance (a) and leaching (b) of different crop rotations at research sites. (a): mean values and standard deviation for 2011-2013; (b): crop mean values for 2012-2013 summed up per crop rotation (triennial).

Results and Discussion

- N balance (Fig. 1a):
  - < 60 kg ha^{-1} in the 3-year-average for all crop rotations
  - silage maize: negative N balance at all sites and crop rotations
  - Aiterhofen: winter wheat (after pre-crop winter wheat) higher balances due to fertilization in autumn to assist straw decomposition
  - Etzdorf: mean N balance of sugar beet in equilibrium but strong differences between years due to severe yield decrease
- N leaching (Fig. 1b):
  - small differences between crop rotations
  - mainly during winter
  - Aiterhofen: high rainfall in May 2013 resulted in high leaching under silage maize and sugar beet
  - sugar beet monoculture (no catch crop) highest leaching in a 3-year calculation

Conclusion

All crop rotations achieved N balances in accordance to DÜV (2012). High summer rainfalls and high N fertilization induced high N leaching which was not indicated by the N balance. Thus, the N balance may not be a precise indicator for harmful N impacts on the environment.

References:

VAN DER BURGT, G. J. H. M., OOMEN, G. J. M., HABETS, A. S. J., ROSSING, W. A. H. (2006): The NDICEA model, a tool to improve nitrogen use efficiency in cropping systems. Nutrient Cycling in Agroecosystems 74, 275-294.

DÜV (2012): Verordnung über die Anwendung von Düngemitteln, Bodenhilfsstoffen, Kultursubstraten und Pflanzenhilfsmitteln nach den Grundsätzen der guten fachlichen Praxis beim Düngen. http://www.gesetze-im-internet.de/bundesrecht/d_v/gesamt.pdf, 18.03.2014.